

## Critical Gaps and Recommendations

This review of the studies on landslides carried out so far in the Sikkim Himalaya has revealed that there is an urgent need for focused investigations to fill gaps with respect to certain critical aspects of landslide investigations.

It is recommended that top priority needs to be given to implement the following:

1. *Preparation of large-scale (1: 500 to 1: 1000) topographic maps for slopes in Gangtok and other areas in Eastern District with known history of mass movements. The contour interval should be 2 m to 5 m.*
2. *Preparation of large-scale geomorphology maps (1: 500 to 1: 1000) for slopes in Gangtok and other areas in Eastern District with known history of mass movements.*
3. *Setting up of a net work of automatic rain gauges on slopes in Gangtok City and other areas in Eastern District with known history of mass movements.*

This would help in the preparation of inventory of all landslides occurring every year in East, South and West districts of Sikkim. This would also require training of manpower for gathering details in a standard proforma sheet designed for the purpose. Exact location in terms of longitude and latitude can be determined through the use of GPS.

4. *Preparation of overburden maps giving depth to hard rock and fluctuation of subsurface water level on slopes in Gangtok and other areas in East District with known history of mass movements. The large-scale topographic maps will form the base for such work.*
5. *Planning and execution of detailed geotechnical investigations of major known landslides in Gangtok City and other areas in East. District. These investigations both in the field and laboratory need to be designed carefully under supervision of geotechnical experts.*



Critical gaps exist in each of these aspects in the currently available landslide information for Sikkim. DST report of the Task Force on Geotechnical Investigations of Landslides (2000) highlights these issues on National level. This situation needs to be remedied on an urgent basis. Emphasis is being placed on East District simply because more than 60% of known landslides have taken place in this area where risk to life and property is maximum. Further more, initial studies need to be confined to Dalings formation only in which 70% of the landslides have occurred. *Such intensive studies in one district and one dominant geologic formation will help produce data on critical aspects of landslides occurring under these conditions.* Furthermore with reliable data on landslide inventory and rainfall during monsoon season, it is possible to establish a quantitative relationship depicting the rainfall threshold for triggering landslides. Long-term data on short duration (at least on hourly basis) rainfall intensity and occurrence of landslides will enable establishment of landslide hazard warning system based solely on rainfall data.

*The suggested program of action, under expert guidance and supervision, should be undertaken by a dedicated group of geologists and geotechnical engineers in the state. Such intensive studies over next 5 years will certainly lead to concrete results in terms of effective landslide hazard warning system and development of cost – effective remedial measures in areas of potential instability in the state. Result of suggested studies would also help to prepare meaningful landslide hazard zonation maps, which are needed, for the identification of critical slopes, vis-à-vis the planned developmental activities.*

It emphasised that without such an intensive and sustained program of investigations, as recommended above, no meaningful improvement in the current situation in respect of landslide hazard is possible. The ongoing disjointed, unfocussed and uncoordinated studies funded by various agencies on landslide hazards in Sikkim are not going to make any significant difference. There is urgent need for pooling together all these resources and channelizing the effort for implementation of the proposed line of action.



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